DOCUMENT RESUME

ED 382 577 SP 035 915

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TITLE Teachers as Researchers in a Community Partnership.
PUB DATE Apr 94
NOTE 8p.; Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 1994).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Descriptive (141)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *College School Cooperation; Elementary Education; Elementary School Curriculum; Elementary School Teachers; Higher Education; *Mathematics Education; *Partnerships in Education; Problem Solving; Program Development; Program Effectiveness; Relevance (Education); *School Business Relationship; *Science Education; *Teacher Role
IDENTIFIERS New York; State University of New York Coll at Oswego; *Teacher Researchers

ABSTRACT

Project SMART (Science and Mathematics Applied Resources for Teaching) is a cooperative partnership of schools, area industries, and the State University of New York at Oswego. In Project SMART's "Kids at Work" program, students learn that math and science skills are needed to reach their career goals, as students make field excursions to area businesses such as a grocery store, a papermaking plant, and an automobile dealership. Businesses/industries selected are those that perform tasks correlated to curricular science and mathematics concepts. The teacher's role is defined as a researcher and manager of the instructional and learning processes. Project SMART methods and materials have been replicated in four elementary schools in central New York school districts, and a replication outline is offered. Evaluation of Project SMART found that it increased the number of teachers who implement hands-on problem solving activities to demonstrate the relevance of math and science to students' present and future lives, and that the Project SMART community partnership provides the organizational structure that enables teachers to understand and improve their classroom practices through collaborative research. (JDD)

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ED 382 577

Teachers as Researchers in a Community Partnership

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American Educational Research Association
New Orleans, Louisiana
April, 1994

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Objectives

The purpose of this paper is to: (1) present teachers' perspectives and involvement in the Project SMART (Science and Mathematics Applied Resources for Teaching) "Kids at Work" Program, (2) describe the role of the teacher as a researcher, and (3) outline a replication plan to assist other educators in developing an interactive partnership between schools, business/industry, and the university.

Perspective and Theoretical Framework

Exposure of the child to the workplace provides a background of time management, the art of cooperation and compromise, care of human needs and problem solving techniques (Swick, 1990). Teachers as researchers also need this exposure in order to make a relevant connection between school and the workplace.

Recognizing that students assume many adult roles, one of which is worker, the task of preparing elementary, middle and secondary school students for the current and future workplace is timely and challenging. The skills needed in the workplace are becoming more complex and demanding. Rapid changes in society call on workers to learn and adapt constantly. It is understood then, why there is a nationwide emphasis on the need to establish programs that will prepare students to develop skills that enable them to succeed in the workplace.

The linkage between school and work, in particular, has emerged as a key issue in work force preparation. This linkage needs to be made early in a child's schooling (New York State Education Department, 1992). A step in that direction could be the use of the workplace as a learning environment. In the Project SMART "Kids at Work" program, students learn that math and science skills are needed to reach their career goals. They develop an understanding that what is learned in school does matter. With teacher direction, students become participants in the learning process rather than passive learners. Therefore, the role of the teacher is defined as a researcher and manager of the instructional and learning processes.

To facilitate this role, the teacher researcher attends the Project SMART summer institute. During this three week session, cooperative partnerships between schools, industry and the university are established in conjunction with the development of science and math activities through an interdisciplinary approach. To support this partnership a variety of resources are necessary including hands-on activities, data collection, literature, field excursions, speakers, texts as a research tool, visual aids, business, industrial and educational consultants, parents and children. It is through this partnership that teacher researchers have the opportunity to collaborate, reflect, and therefore understand and improve their own classroom practices. This, in turn, can increase teachers' participation in educational decision-making and ensure that research will focus on genuinely useful questions and issues that will advance student learning.

Historical Overview of the Project

In 1986, a needs assessment conducted by the Oswego County Teacher Center in New York State confirmed that teachers felt they had weak science and mathematics preparation, were unfamiliar with new teaching methods, and distrusted their ability to implement a hands-on

problem solving curriculum. To address these needs, university faculty and community representatives from Oswego County met with the Triangle Coalition, a group that encourages school, university and business partnerships. With the Coalition assistance and guidance from the Classroom Interaction Research Laboratory (now known as the Institute for Interdisciplinary Educational Studies (IIES) at the State University of NY at Oswego, Project SMART was organized. Further guidance became available with the establishment of a steering committee comprised of representatives from throughout the community. Grant funding was sought and received from state, federal and private sources and then used for the resources and the processes needed to make the connections between classroom learning and the workplace.

What is Project SMART?

Project SMART (Science/Mathematics Applied Resources for Teaching) is a cooperative partnership of schools, area industries, and the State University of New York at Oswego. It is aimed at stimulating teachers' and students' interests and understanding of science and mathematics as applied in the workplace. In the school/industry partnership program, teachers and college faculty work with business and industry to develop math and science units and kits. The industries involved make their plants available for field excursions for children from area schools. The Project SMART teachers (facilitators) and industry representatives offer staff development workshops for teachers. Research and dissemination are ongoing.

The Project SMART "Kids at Work" program improves the science and mathematics skills of kindergarten through sixth grade teachers and in turn the attitudes of their students (Gooding, Weber, Beyerbach, 1991). The process of inquiry learning aids the teacher researcher in investigating the correlation between school and the workplace thus helping students find answers to "What do I have to learn about science and mathematics?"

The "Kids at Work" program is based on objectives of the innovative New York State elementary science and mathematics syllabi, and is infused into the regular school curriculum. A significant component of the "Kids at Work" partnership is the industrial alliance. The businesses or industries that are selected for field excursions are those that perform tasks directly correlated to science and mathematic concepts already taught. Personnel from these businesses serve the project in several capacities. Several are members of the steering committee which has the responsibility of providing a broad oversight, and responding to concerns addressed by partners. Subcommittees focus on long range planning, evaluation and public relations. Industrial members collaborate with the teams at the summer institute that write the curriculum and develop materials related to the industrial field excursion. These members offer technical expertise, insights into the industry, and materials for the staff development guides and kits. Participating industries include a grocery store, a papermaking plant, a food processing plant, a newspaper, a dairy operation, a fossil fuel electric generation plant, and automobile dealership, and an aluminum rolling plant.

In an effort to enhance the dissemination and utilization of Project SMART methods and materials in the schools, a proposal was developed for a new D.D.Eisenhower Title IIA grant project for a site-based initiative to involve whole school implementation in four test sites. The new model involves the entire faculty and principals of four elementary schools, one school site in each of four different central New York school districts. It is based on the summer institute and turn-key models in which selected teachers learn strategies for educational leadership.

These were pioneered by the National Science Foundation in the 1960's and 1970's and form the basis for the New York State Elementary Science Mentor Program. We have extended this successful paradigm to the building level, as we educate science facilitators in effective workshop presentation and peer coaching strategies, and help them develop the skills necessary to implement an effective science improvement plan. The research indicates that enduring changes in teaching methods are far more likely to occur if exemplary practice is modeled in both workshop and classroom settings, teachers have opportunities for practicing new skills with supportive feedback, and the principal orchestrates the development of positive attitudes among teachers, children and parents (Showers, Joyce & Bennett, 1987).

Teacher Involvement

Teachers are recruited or recommended by their administrators for the summer program. These teachers attend workshops held by Project SMART staff or experienced Project SMART teachers, participate in seminars in such varied areas as technology, software, science and math manipulation, pedagogy of teaching, gender issues and multicultural classroom teaching techniques. They collaboratively develop materials, design inservice workshops, and develop building and district implementation plans. They become advocates in their own school districts, working in collaboration with their administrators and industrial liaisons to build community pride and support for improved elementary science and mathematics instruction in schools (Gooding, et al. 1993).

"Kids at Work" materials use a modified learning cycle instructional model (BSCS, 1989; Karplus & Thier, 1967, Renner & Marek, 1988), in which children first explore the concept concretely, then the teacher explains and clarifies the concept through class discussion, and finally the children apply the concept to a new, related problem. During the summer institute the teachers both experience this learning cycle and then use the model for the creation of the curriculum and field excursion guides. After the summer institute experience, the participants are designated as Project SMART Facilitators. These Facilitators simultaneous take on the role of teachers as researcher.

Area teachers not involved in the summer program also benefit from Project SMART. To prepare to teach a unit, teachers attend a workshop conducted by Project SMART facilitators. The workshops are conducted at a business or industrial site that is serving as a Project SMART partner, and feature a version of the children's field trip expanded for adults, as well as an introduction to the pre-post trip classroom activities. Workshops are conducted either after school or during staff development conference days. County-wide workshops offer a unique opportunity for teachers to collaborate across districts thus helping to remove teacher isolation. One of the partnership roles that school administrators play is to facilitate the release of their staff members to conduct workshops or peer coaching sessions in other area schools, and for pre-service education classes at the local university.

Objective 1: The Role of Teacher as Researcher

"There is growing support for the notion that research by teachers about their own classroom and school practices can function as a powerful means of professional development and also contribute to the knowledge base in education" (Cochran-Smith & Lytle, 1992). The Project SMART "Kids at Work" program supports teacher research and encourages teacher inquiry.

Teacher empowerment and shared decision-making allows Project SMART teacher participants to be actively involved in the process of developing, implementing, and evaluating "Kids at Work" activities. This project aims at stimulating elementary teacher and student interest and understanding of science and mathematics in the workplace.

Definition of the Teacher as Researcher in the Project SMART Program

Over 100 teachers have participated in the summer institutes. This broad-based network provides year round support. These Project SMART teachers field test new "Kids at Work" and syllabus-based units within their own classrooms. Their observations and recommendations are then shared with the development team and revisions are made. Each of these teachers are researchers throughout the year. The data they collect through observation, surveys and other means shape the course of Project SMART, change goals and objectives and direct grant writing which sustains the project. At this level of involvement, these active teacher participants are referred to as Project SMART Facilitators. Recently, the data that were collected by these facilitators and the staff of Project SMART formed the basis for a New York State Validated Programs in Sharing Successful Education Practices proposal. Project SMART "Kids at Work" will receive the validation award on April 28, 1994.

As the facilitators gain experience in the project their focus on research in practice changes. Their classrooms form the pilot sites for experimental approaches and data collection. Results are reported at the local, state and national levels. Facilitators also model the integrated, hands-on curriculum for undergraduate and graduate classes. They have developed and are instructing a Project SMART Graduate course that fulfills university and inservice credit. Others are site-based coordinators who work with teachers during the three week summer institute to develop district needs assessments and tentative plans for implementation. The site-coordinator then acts as a liaison between the school district's SMART teachers, the district staff and the university experts.

One of the facilitators has been granted a one year leave with partial support from a school district to join the Project SMART staff at the university. She serves as a researcher in the Classroom Interaction Research Laboratory, an adjunct professor for pre-service mathematics courses implementing the Project SMART philosophy, serves as a site-coordinator in two schools, and writes and edits materials to be used in future Project SMART workshops. She also serves as a liaison to businesses and industry and is giving talks at state and national meetings concerning Project SMART.

Other experienced Project SMART Facilitators have developed, and are currently teaching a graduate course in Project SMART to 25 area educators. The course is being offered to fulfill approved by the university for credit as well as being approved for inservice credit by cooperating school districts.

Evaluation Data Indicating the Effectiveness of the Program

Three instruments provided information on the effectiveness of Project SMART, as follows: (1) the ESPET Student Program Environment Survey was administered to fourth grade children in the spring of 1990 (N = 1106 in eight districts) and spring of 1993 (N = 1813 in nine districts; the same 8 districts were used in 1990-93 comparisons, N=1429), (2) the ESPET Student

Science Attitude Survey was also administered to the same population of fourth graders in 1990 (N = 1527 in eight districts) and 1993 (N = 1847 in nine districts; the same 8 districts were used in the 1990-93 comparison, N=1460), (3) the Science Utility Evaluation (SUE) was administered at the end of the school year in the two sixth grade classrooms in which extensive classroom observations were done (N = 26 in the Project SMART classroom and 22 in the comparison group).

Consistent differences were observed in student attitudes and student program environment responses favoring Project SMART when Project SMART teachers' classrooms were compared to non-Project SMART teachers' classrooms and when site schools were compared to non-site schools. Students in site schools and students in classrooms of Project SMART teachers described significantly enhanced environments for learning as compared to non-Project SMART students on the Student Program Environment Survey. Students in site schools responded significantly more positively on 13 out of 25 items than those in non-site schools. Students in classrooms of Project SMART teachers described even more enhanced environments, responding significantly different on 18 out of 25 items. Two items indicated significant differences in an unexpected direction; children in Project SMART classrooms were more likely to share a book with a peer (probably because they used more trade books), and were less likely to report that the classroom is organized so that when they needed something they knew where to find it (probably because their classrooms were more complex, with more hands-on "stuff"). Students in both site schools and in classrooms of Project SMART teachers were significantly more likely to report they do science three or more times a week, go outside to study science, go on field excursions to study science, have science projects to do at home, have enough supplies to work with a small group, think learning science is fun, have science activities to do on their own, use books other than the text, experience science lessons where teachers help one another, have their science work displayed, and have people come to their class to talk about things they are studying in science.

Data from the 1993 administration of the SUE, a quantitative attitudinal survey in these two classrooms indicate that students in the Project SMART classrooms had significantly enhanced attitudes towards science. The experimental group size was 26 and the comparison group was 22. Because of the small sample size and a large number of variables, inferential statistics are inappropriate. It was decided to report only those items that have at least a 15% differential between the experimental group and the comparison group.

The results of the SUE indicated striking differences in the attitudes of the students in the two classes. Students in the Project SMART class were much more likely to indicate that they (1) enjoyed school science; (2) felt interested in school science; (3) saw it as useful outside of school; (4) recognized that science helped them understand the world around them; (5) declared that learning science is fun; and (6) liked science. The findings strongly support the use of Project SMART units as a means of positively increasing students' attitudes toward science and promoting a desire for future learning in the student.

Objective 3: Replication Outline

How can you use Project SMART in your district? The project could be initiated by a group of teachers, administrators, business and industry representatives or other advocates for improving school math and science. We recommend the following procedures.

1. A needs assessment should be conducted.
2. Community groups committed to change could form a group that might contact an alliance such as the Triangle Coalition or a Sharing School Programs validated group such as Project SMART.
3. A steering committee could be formed to guide the future course of the project and to assist in establishing goals and exploring ways to finance the program.
4. Exploration into ways to form the human resources needed for the project (i.e., teachers, parents, business/industry personnel, university faculty and staff or area content specialists) could then proceed.
5. A time-table of events would be set, and recruitment begun.
6. Evaluation instruments would then be determined.
7. The program could then begin. (Cost of replication of this program should be relatively inexpensive).

Conclusions

Project SMART increases the number of teachers who (1) are researchers (2) are aware of and use community resources related to math and science instruction, (3) design and participation for relevant staff development opportunities in their district, and (4) implement hands-on problem solving activities to demonstrate the relevance of math and science to students' present and future lives. The Project SMART community partnership provides the organizational structure that enables teachers to understand and improve their classroom practices through collaborative research.

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